**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Idaho – Pocatello**

**Idaho Water Resources**

*Estimating Soil Moisture in Semiarid Sagebrush Steppe using NASA Satellite Imagery*

**Project Overview**

***Project Synopsis*:**

Water storage in arid landscapes is paramount to the survival of natural flora and fauna and thus of vital importance for landscape management encompassing these areas. Understanding soil moisture and storage capacity is also of interest to ongoing research focused on the interdependence between water resources and energy use and production. NASA DEVELOP aims to investigate soil moisture across the sagebrush-steppe ecosystem of the Intermountain West to determine if critical indicators of landscape health can be approximated using NASA Earth observing satellites. Using spaceborne data collected from SMAP and GPM from 2015 to present, Aqua and Terra MODIS from 2000 to present, SRTM, and modeled data from MOSAIC and MERRA-2, this project will provide a method for monitoring soil moisture in this ecosystem. Integrating vegetation productivity, soil moisture data, precipitation, and fusion products from MERRA-2 and NLDAS-2 Mosaic will provide land managers with a more robust picture of ecosystem health in these specialized regions.

***Community Concern:***

Soil moisture is one of the primary determinants of ecosystem health in arid and semi-arid Idaho landscapes. Accurately predicting the timing and extent of soil saturation in Idaho can lead to streamlined management practices, better constraints on “green-up” timing, and fire hazard assessments. With precipitation serving as the primary driver of ecosystem health in these environments, accurate estimates of soil water content are vital. Land managers can then use this information to better understand grazing impacts, determine fire susceptibility, and target native plant recovery strategies following a disturbance. These data can also be used to better understand water availability and scarcity issues across the region.

***Source of Project Idea:*** The Idaho – Pocatello node’s Lead Science Advisor, Keith Weber, began developing this project in fall 2017 after a discussion with several potential partners at the Idaho National Lab.

***National Application Area Addressed:*** Water Resources

***Study Location:*** ID

***Study Period:*** January 2000 – Present

***Advisor:*** Keith Weber (Idaho State University, GIS TReC)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **US Fish and Wildlife Service, Eastern Idaho Field Office** | Evan Ohr, Biologist;  Lisa Dlugolecki, Biologist;  Matt Bringhurst, Soil Conservation Tech | End User | Yes |
| **Idaho Department of Fish and Game, Southeast Regional Office** | Scott Bergen, Sr. Wildlife Research Biologist | End User | No |
| **USDA, Natural Resources Conservation Service, Pocatello Field Office** | Nate Matlack, Soil Conservationist;  Trudy Pink, Resource Soil Scientist | Collaborator | No |
| **Idaho National Laboratory** | Tammie Borders, Research Scientist;  Trent Armstrong, Research Scientist | Collaborator | No |
| **USDA, Agricultural Research Service, Northwest Watershed Research Center** | Dr. Patrick E. Clark, Range Scientist | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:*** The US Fish and Wildlife Service is an integral part of the Department of the Interior, facilitating communication and consulting with other land management agencies to better protect ecosystem health. In the Intermountain West, the health of viable grazing lands is primarily controlled by precipitation combined with soil absorption and permeability. Currently, specified areas of concern for threatened species are noted as priority conservation areas. These areas are currently defined via field work and shared information between a variety of state and federal agencies; however, remote sensing has yet to be fully leveraged for these applications.

***End User’s Capacity to Use NASA Earth Observations:***

*US Fish and Wildlife Service, Eastern Idaho Field Office* – Currently, the Eastern Idaho Field Office uses limited remote sensing for map creation and decision support. This project will familiarize the USFWS with additional remote sensing resources and the opportunity to expand their usage of NASA Earth observations.

*Idaho Department of Fish and Game, Southeast Regional Office* – IDFG’s research and management groups currently use satellite-derived imagery (e.g. MODIS, Landsat) for natural resource management throughout the state of Idaho. Satellite data are used to meet some specific informational needs. Examples of IDFG’s use of satellite data include: annual vegetation production (phenology metrics from MODIS), invasive species detection (OLI, ETM+, TM), and fire recovery estimation (dNBR). Typically, Scott Bergen assists in developing methodological protocols and interpretation of results. Dr. Bergen had successfully completed his Ph.D. under NASA’s LBA project as well as subsequent EOS postdocs.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*USDA Agriculture Research Service, Northwest Watershed Research Center* – Our partner at the USDA ARS is tasked with monitoring and researching soils in the Reynolds Creek Critical Zone. This collaboration will allow for ground-truthing satellite-derived data based on available field measurements collected by this research team.

*Idaho National Laboratory* – The INL along with the Department of Energy is broadly interested in expanding their use of GIS and remote sensing for water security applications, enabling more effective management of water resources by determining landscape-level quantities and movement through a water system. The INL will provide scientific guidance as well as ancillary datasets.

*USDA, National Resources Conservation Service* – Currently, the USDA NRCS uses airborne imagery and limited vegetation/change detection via remote sensing for landscape monitoring. They will provide project guidance and secondary scientific advising for the project.

***Dissemination by Boundary Organizations*:**

*US Fish and Wildlife Service, Eastern Idaho Field Office* – The USFWS is charged with maintaining partnerships and consulting with other agencies under the Department of the Interior as well as state and private partners. USFWS will be the focal point for data and collaboration between various other partners. In addition, they will provide input for water resource management in relationship to endangered and threatened species in the Intermountain West.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication between the DEVELOP team and project partners will occur every two weeks via teleconference or in-person meetings. Weekly update e-mails will be sent summarizing the current state of the project and any pertinent questions. Lines of communication will remain open if issues arise, but these meetings will primarily involve project updates and high-level results. The Center Lead will coordinate an initial project meeting within the first two weeks of the term and will transition this responsibility to the Project Lead. Initial communications will be collaborative, involving all partners to determine key project goals. As the term progresses, the Project Lead will keep partners updated on project progress and relay partner feedback to the team.

***Transition Plan*:** End users will be granted access to the data, technical paper, and project video directly through NASA Large File Transfer or via physical electronic transfer devices. Final imagery will be disseminated electronically following closeout, with a software release occurring, if necessary, via the proper channels.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **SMAP Radiometer** | Soil moisture | SMAP will be used to determine soil moisture content. |
| **GPM GMI** | Precipitation | GPM products will be used to approximate near-real time precipitation intensity. |
| **Terra MODIS** | NDVI | MODIS will be used to monitor vegetation health. NDVI maps will provide estimates for vegetation health, which will support soil moisture data validation. |
| **Aqua MODIS** | NDVI | MODIS will be used to monitor vegetation health. NDVI maps will provide estimates for vegetation health, which will support soil moisture data validation. |
| **SRTM** | Elevation | SRTM will provide the elevation data necessary to create aspect and slope which will be important parameters for hydrologic transportation. |

***Ancillary Datasets:***

NASA Modern-Era Retrospective Analysis for Research and Applications Reanalysis Model (MERRA-2) – Precipitation inputs; Modeled soil moisture and evapotranspiration data.

USDA Natural Resources Conservation Service Soil Survey Data – Survey-based dataset providing soil information (Updated October 2016)

USDA Natural Resources Conservation Service Soil Climate Analysis Network (SCAN) – Ground-based dataset providing soil moisture at various depths and related data. (Updated 2018)

Parameter-elevation Relationships on Independent Slopes Model (PRISM) – Time-series temperature and precipitation data (1979-2018)

Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) – Interpolated global rainfall estimates based on TRMM and localized station data (1981-2018)

***Modeling:***

NLDAS-2 Mosaic Land Surface Model (POC: Dr. Kenton Ross, DEVELOP National Program Office)

***Software & Scripting:***

TerrSet – Raster manipulation and image processing

Esri ArcGIS – Raster manipulation and analysis, map creation

Python – Scripting and raster analysis

Excel -– Statistical analysis

R – Statistical analysis

Adobe Creative Suite – Graphic creation and map manipulation

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Soil Moisture Maps – Vegetation/Soil Moisture** | These will provide partners with information about the timing of peak NDVI with soil moisture data. The maps will provide historical data, hopefully showcasing areas and timing of yearly concern. | SMAP radiometer surface soil moisture measurements combined with Aqua/Terra MODIS vegetation indices and SRTM elevation data | N/A |
| **Soil Moisture Maps – Precipitation/ Soil Moisture** | These maps will provide end users with information about the soils their relationship to regional precipitation trends. This can help partners identify locations with hydrophobic soils. | SMAP radiometer surface soil moisture measurements combined with GPM GMI precipitation measurements and SRTM elevation data | N/A |

***End-User Benefit*:**

The various end-products created by the team will provide partners with better data and visualizations of soil moisture for various land management practices. In the case of livestock grazing, this will allow for better estimates of vegetation health and will enable more sustainable use of arid landscapes. For fire management, pre-fire estimates of soil moisture can save a lot of time and money—complimenting limited existing soil monitoring sites. This work will provide a robust baseline for understanding the regional water budget, which will serve as a foundation to provide partners with a more holistic picture of water resources during the fall 2018 continuing project term.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2018 Summer to 2018 Fall

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2018 Summer (Idaho - Pocatello) – Idaho Water Resources
  + The summer term project is focused on satellite-derived soil moisture and precipitation correlated with modeled data. Partners will provide information about landscapes and soil moisture for study locations. This will set the stage for a more comprehensive look at water budgets in the study region and incorporating evapotranspiration measurements in the continuing fall term.
* **Term 2:** 2018 Fall (Idaho - Pocatello) – Idaho Water Resources II
  + A proposed second term project would build off SMAP and modelled data previously utilized to include a more holistic exploration of water balance measurements in the system. This will incorporate MODIS (MOD16) evapotranspiration products, and other evapotranspiration-focused datasets. The methods will be expanded to focus on study areas featuring smaller, fragmented patches of rangeland.

***Related DEVELOP Work:***

2016 Summer (WC) – Southeast US Agriculture: Incorporating NASA Earth Observations into the USDA Southeast Regional Climate Hub Lately Identified Geospecific Heightened Threat System (SERCH LIGHTS) to Assist Farmers in Making Informed Decisions on Water and Crop Management

2016 Spring (LaRC) – Texas Water Resources: Utilizing NASA Earth Observations to Assess Soil Moisture in Texas for Wildfire Mitigation